“Why Are We Here?”*

Energy Frontier All Hands #1

*Thanks, Michael.

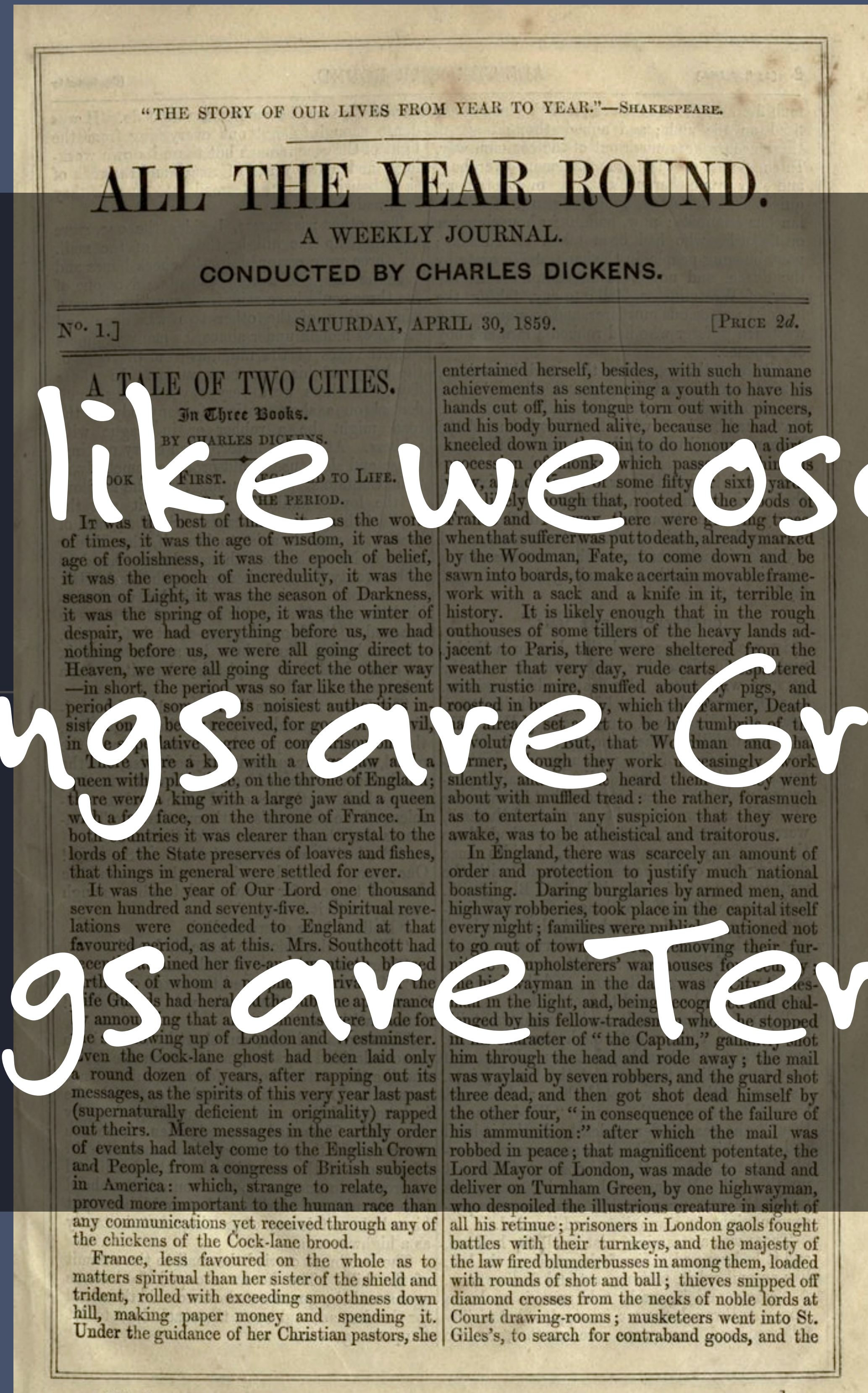
April 3, 2013
Michael Peskin (SLAC)
Chip Brock (MSU)

TOC

1. Energy Frontier Now
2. Snowmass2013 Energy Frontier Process
3. Housekeeping

1. Energy Frontier Now

do we really need inspiration?



"THE STORY OF OUR LIVES FROM YEAR TO YEAR."—SHAKESPEARE.

ALL THE YEAR ROUND.

A WEEKLY JOURNAL.

CONDUCTED BY CHARLES DICKENS.

No. 1.] SATURDAY, APRIL 30, 1859. [PRICE 2d.

A TALE OF TWO CITIES.

seems like we oscillate:

Things are Great!

Things are Terrible!

"THE STORY OF OUR LIVES FROM YEAR TO YEAR."—SHAKESPEARE.

ROUND.

BY CHARLES DICKENS.

PRICE 2*d*.

BOOK THE FIRST. RECALLED TO LIFE.

CHAPTER I. THE PERIOD.

It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to Heaven, we were all going direct the other way —in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only.

There were a king with a large jaw and a queen with a plain face, on the throne of England; there were a king with a large jaw and a queen with a fair face, on the throne of France. ...

Even the Cock-lane ghost had been laid only a round dozen of years, after rapping out its messages, as the spirits of this very year last past (supernaturally deficient in originality) rapped out theirs. Mere messages in the earthly order of events had lately come to the English Crown and People, from a congress of British subjects in America: which, strange to relate, have proved more important to the human race than any communications yet received through any of the chickens of the Cock-lane brood.

France, less favoured on the whole as to matters spiritual than her sister of the shield and trident, rolled with exceeding smoothness down hill, making paper money and spending it. Under the guidance of her Christian pastors, she

... warehouses for security ... the dark was a City tradesman ..., and, being recognised and challenged by his fellow-tradesman whom he stopped in his character of "the Captain," gallantly shot him through the head and rode away; the mail was waylaid by seven robbers, and the guard shot three dead, and then got shot dead himself by the other four, "in consequence of the failure of his ammunition:" after which the mail was robbed in peace; that magnificent potentate, the Lord Mayor of London, was made to stand and deliver on Turnham Green, by one highwayman, who despoiled the illustrious creature in sight of all his retinue; prisoners in London gaols fought battles with their turnkeys, and the majesty of the law fired blunderbusses in among them, loaded with rounds of shot and ball; thieves snipped off diamond crosses from the necks of noble lords at Court drawing-rooms; musketeers went into St. Giles's, to search for contraband goods, and the

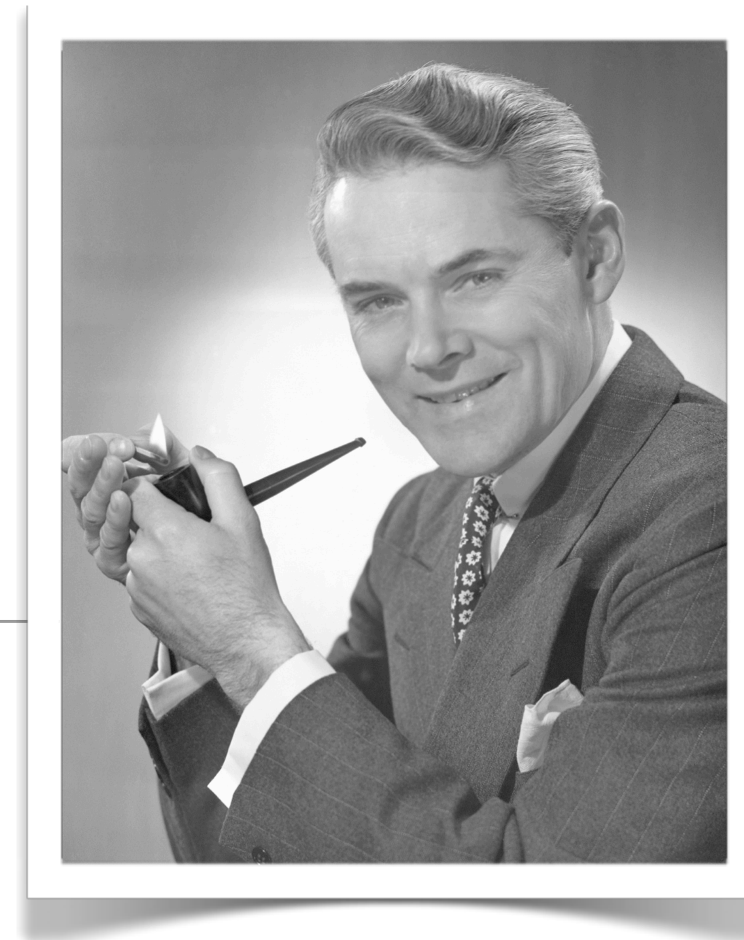
VOL. I.

Isn't this the best of times

and the best of times?

the 2012 discovery

0^+ object is not your father's particle



the 2012 discovery

0^+ object is not your father's particle

it's historic in its genesis

Maxwell had Faraday, Bohr had Rutherford, Gell-Mann had cosmic rays

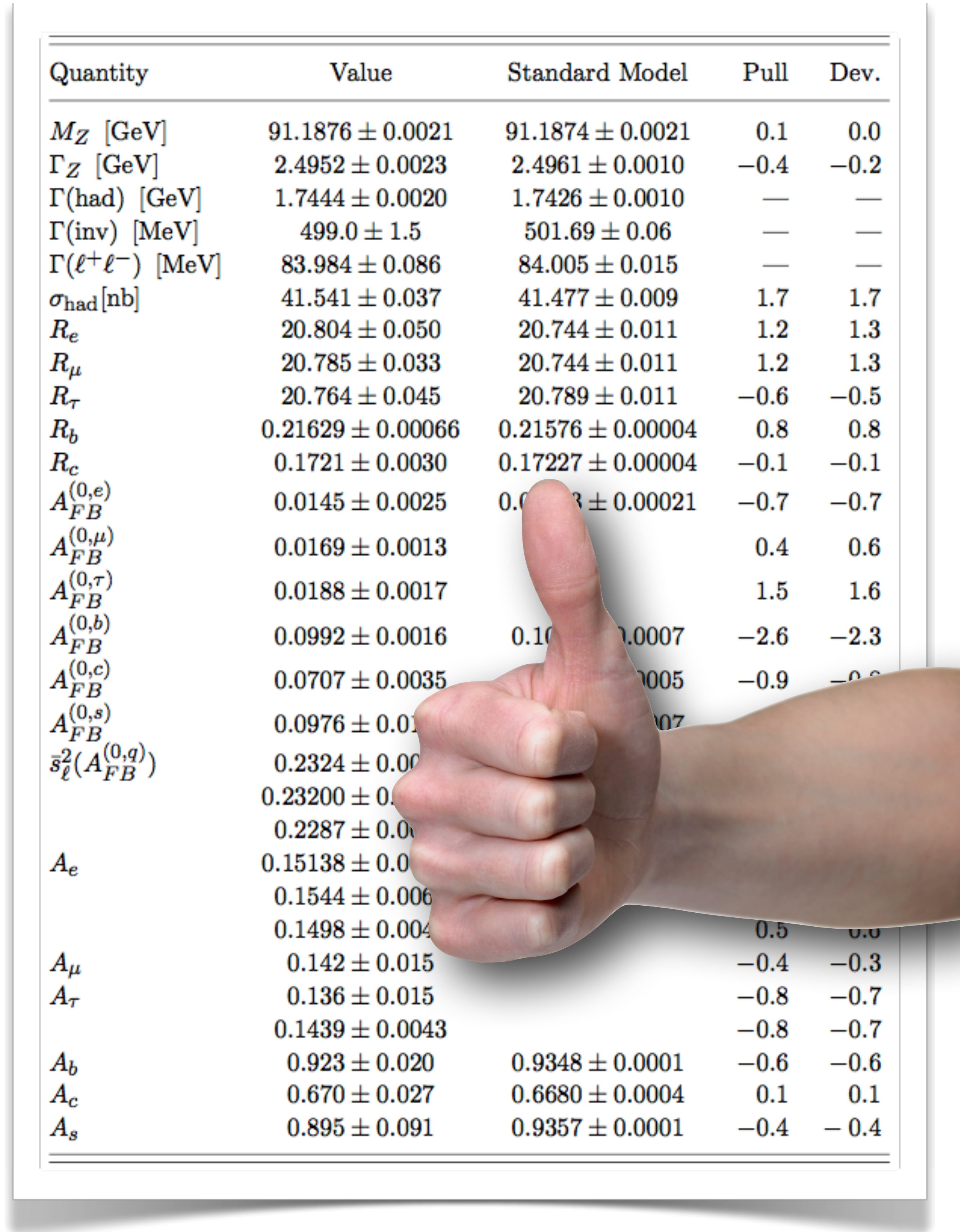
it's historic in the tenacity of the pursuit

Tenacious 40 year, world-wide effort. Tenacious model!

it's historic in what it means.

Amazing Standard Model

The most precise scientific model in the history of mankind

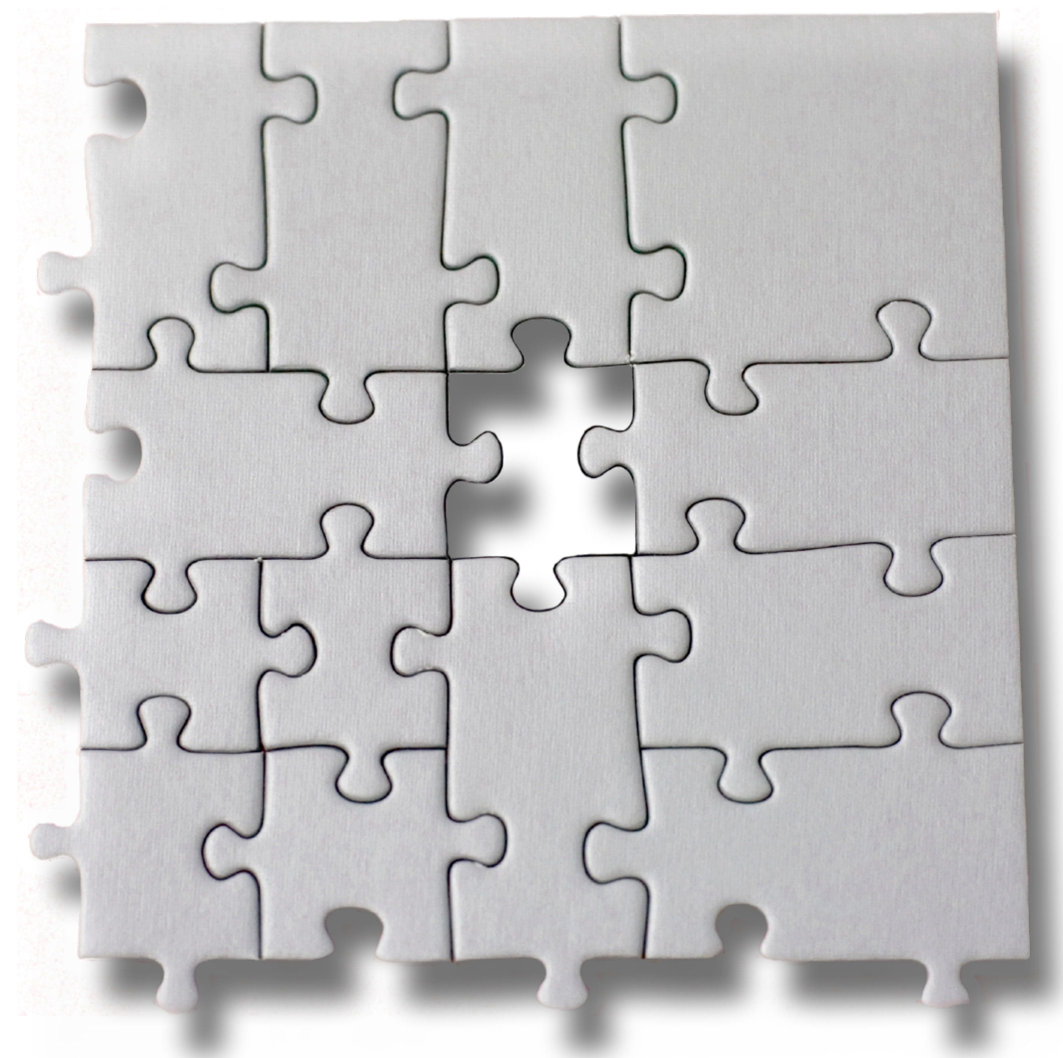


Quantity	Value	Standard Model	Pull	Dev.
M_Z [GeV]	91.1876 ± 0.0021	91.1874 ± 0.0021	0.1	0.0
Γ_Z [GeV]	2.4952 ± 0.0023	2.4961 ± 0.0010	−0.4	−0.2
$\Gamma(\text{had})$ [GeV]	1.7444 ± 0.0020	1.7426 ± 0.0010	—	—
$\Gamma(\text{inv})$ [MeV]	499.0 ± 1.5	501.69 ± 0.06	—	—
$\Gamma(\ell^+\ell^-)$ [MeV]	83.984 ± 0.086	84.005 ± 0.015	—	—
σ_{had} [nb]	41.541 ± 0.037	41.477 ± 0.009	1.7	1.7
R_e	20.804 ± 0.050	20.744 ± 0.011	1.2	1.3
R_μ	20.785 ± 0.033	20.744 ± 0.011	1.2	1.3
R_τ	20.764 ± 0.045	20.789 ± 0.011	−0.6	−0.5
R_b	0.21629 ± 0.00066	0.21576 ± 0.00004	0.8	0.8
R_c	0.1721 ± 0.0030	0.17227 ± 0.00004	−0.1	−0.1
$A_{FB}^{(0,e)}$	0.0145 ± 0.0025	0.0[illegible] ± 0.00021	−0.7	−0.7
$A_{FB}^{(0,\mu)}$	0.0169 ± 0.0013		0.4	0.6
$A_{FB}^{(0,\tau)}$	0.0188 ± 0.0017		1.5	1.6
$A_{FB}^{(0,b)}$	0.0992 ± 0.0016	0.10[illegible]0.0007	−2.6	−2.3
$A_{FB}^{(0,c)}$	0.0707 ± 0.0035	[illegible]005	−0.9	[illegible]
$A_{FB}^{(0,s)}$	0.0976 ± 0.01[illegible]	[illegible]07	[illegible]	[illegible]
$\bar{s}_\ell^2(A_{FB}^{(0,q)})$	0.2324 ± 0.00[illegible]	[illegible]	[illegible]	[illegible]
	0.23200 ± 0.[illegible]	[illegible]	[illegible]	[illegible]
	0.2287 ± 0.0[illegible]	[illegible]	[illegible]	[illegible]
A_e	0.15138 ± 0.0[illegible]	[illegible]	[illegible]	[illegible]
	0.1544 ± 0.006[illegible]	[illegible]	[illegible]	[illegible]
	0.1498 ± 0.004[illegible]	[illegible]	0.5	0.[illegible]
A_μ	0.142 ± 0.015		−0.4	−0.3
A_τ	0.136 ± 0.015		−0.8	−0.7
	0.1439 ± 0.0043		−0.8	−0.7
A_b	0.923 ± 0.020	0.9348 ± 0.0001	−0.6	−0.6
A_c	0.670 ± 0.027	0.6680 ± 0.0004	0.1	0.1
A_s	0.895 ± 0.091	0.9357 ± 0.0001	−0.4	− 0.4

J. Beringer *et al.*(PDG), PR **D86**, 010001 (2012) (http://pdg.lbl.gov)

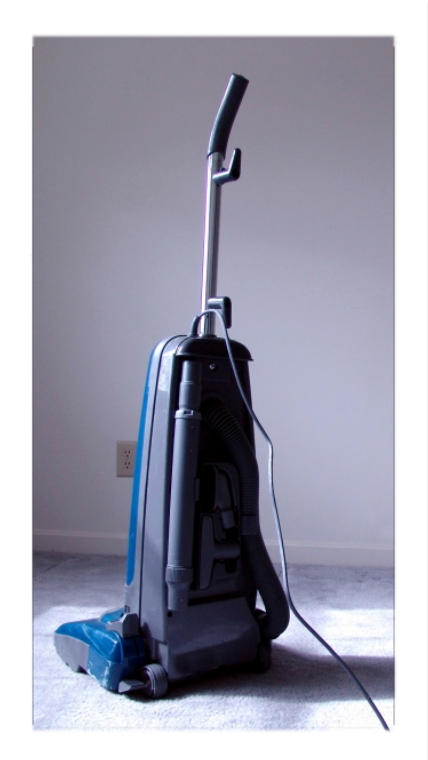
Amazing Standard Model

The most precise scientific model in the history of mankind



J. Beringer *et al.*(PDG), PR **D86**, 010001 (2012) (http://pdg.lbl.gov)

a piece of the vacuum!



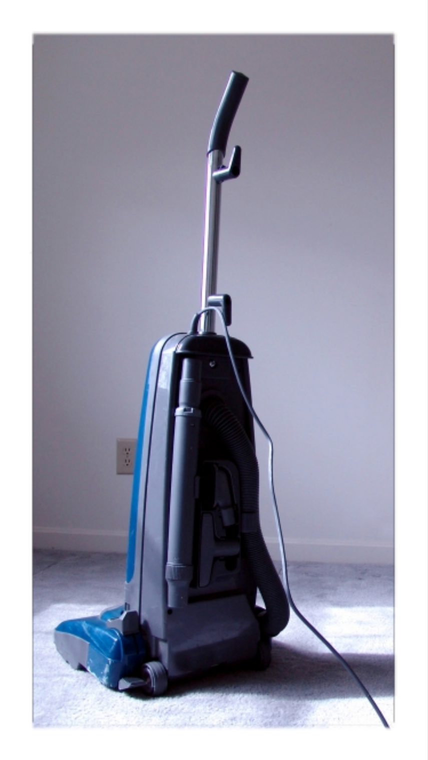
A spin-zero, neutral state has the quantum numbers of nothing.

The question:

Is “0+” an excitation of the frozen Higgs Field?*

*Schwinger-Ginsburg-Landau-Anderson-Englert–Brout–Higgs–Guralnik–Hagen–Kibble Field?

a piece of the vacuum!



A spin-zero, neutral state has the quantum numbers of nothing.

The question:

Is “0+” an excitation of the frozen Higgs Field?*

or an imposter!

*Schwinger-Ginsburg-Landau-Anderson-Englert–Brout–Higgs–Guralnik–Hagen–Kibble Field?

Higgs Smoking guns

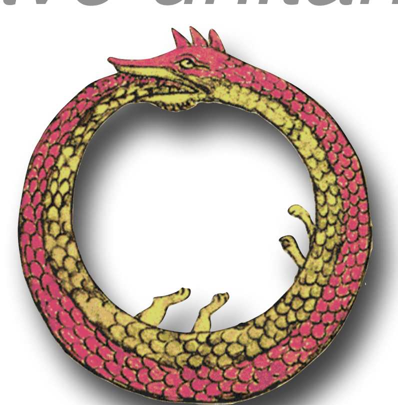
Yukawa couplings?

do the couplings follow the fermion masses?

Longitudinal *V* content?

does EWSB save unitarity?

Self-couplings?



Deep Puzzles

at least a couple

always before theoretical puzzles...

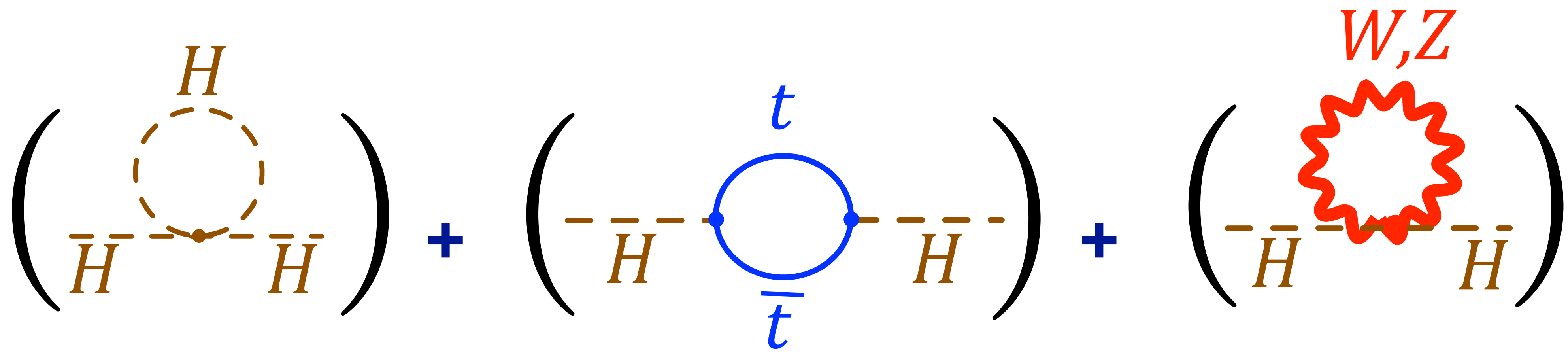
but now experimental puzzles

Light mass = mass confusion

quadratic divergences...”naturalness problem”

better: the “Naturalness Hint”

$m_H - m_{\text{bare}}$ =



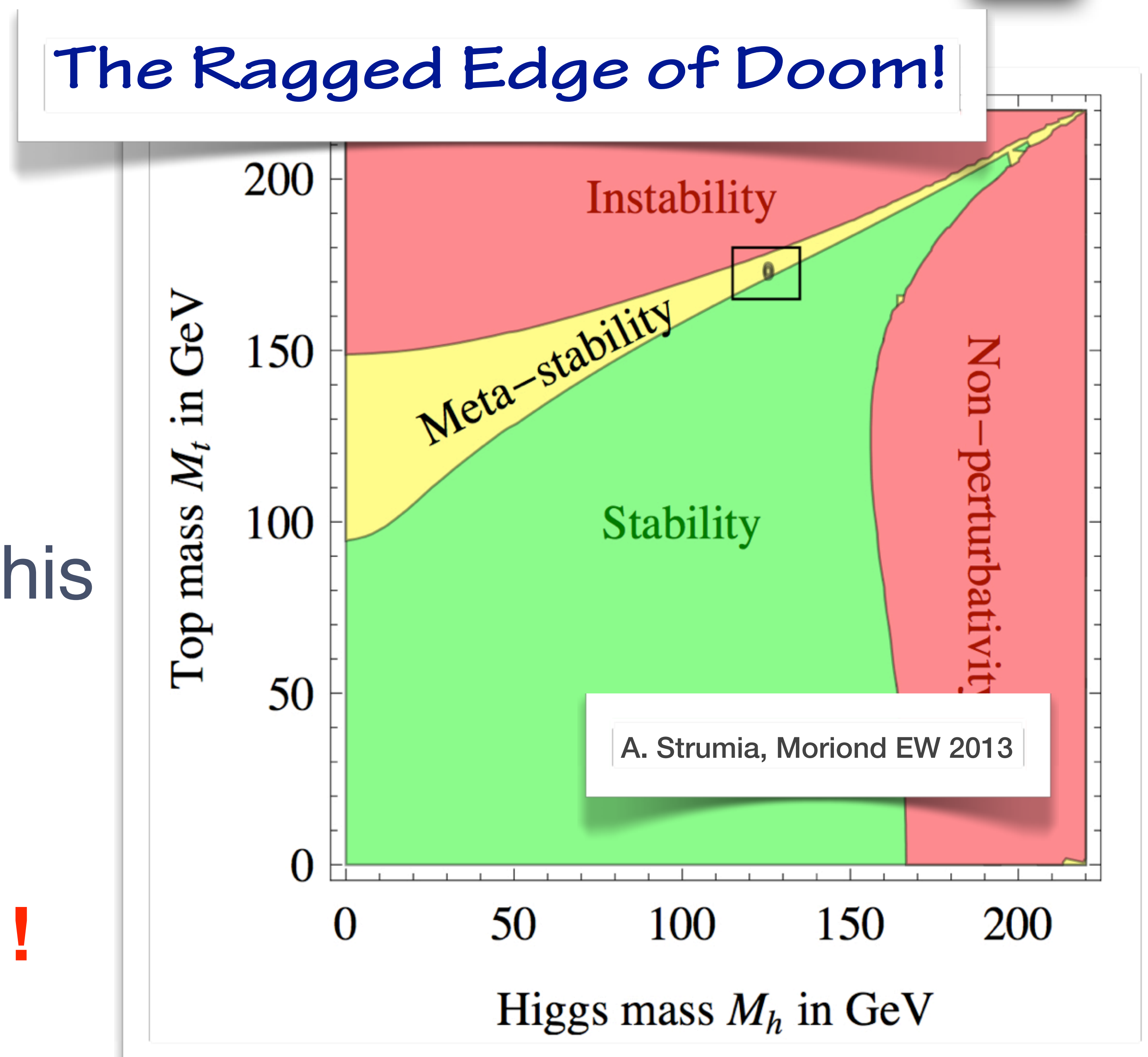
Taming this surely requires New Physics:

a symmetry? compositeness? third generation!

Do we really imagine living with a cut-off?

the top mass is important!

$$
\begin{aligned}
< 0|h|0 > &= v \\
&= (G_F\sqrt{2})^{-1/2} \\
&= 246\ \mathrm{GeV/c^2} \\
&\sim m_t
\end{aligned}
$$



Plus:

The press has enjoyed this

m_t? sensitive!

M_H? notsomuch!

The importance of *top* !

Peskin/Brock, BNL, April 2013

the IVBs are important!

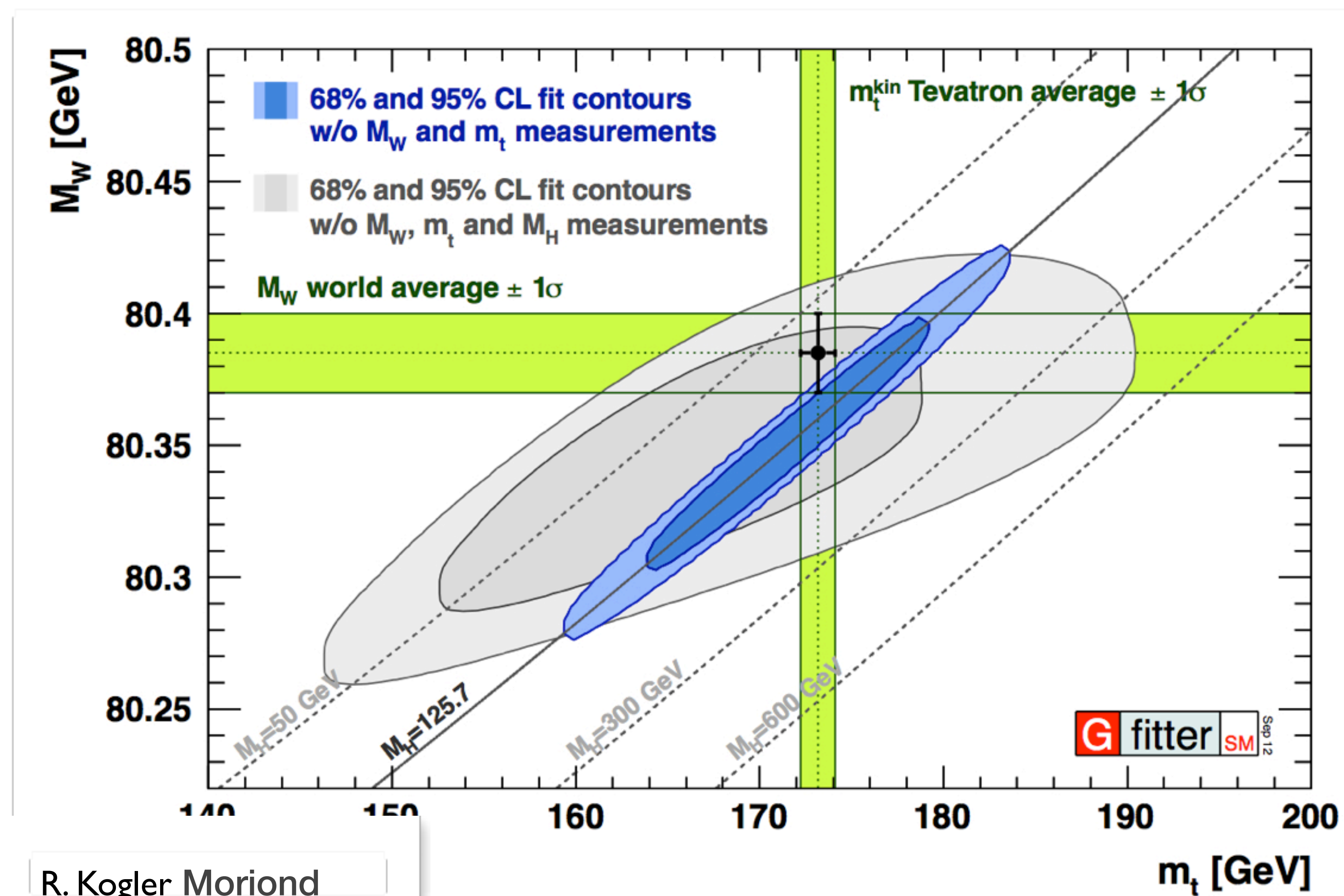
Pressing on SM consistency: the need for all manner of complicated QCD understanding.

M_W? sensitive!

m_t? notsomuch!

The importance of *W* !

- but also the Gauge Couplings of the Spin 1 Bosons...
- connect to all kinds of new physics



R. Kogler Moriond

Why we're here?

To figure out the best way to:

1. Study the Higgs-like state at 125 GeV

Higgs Top EW QCD NP Flav

Higgs
Top
EW
QCD
NP
Flav

2. Answer some troublesome questions

3. Write the story that encompasses the SM

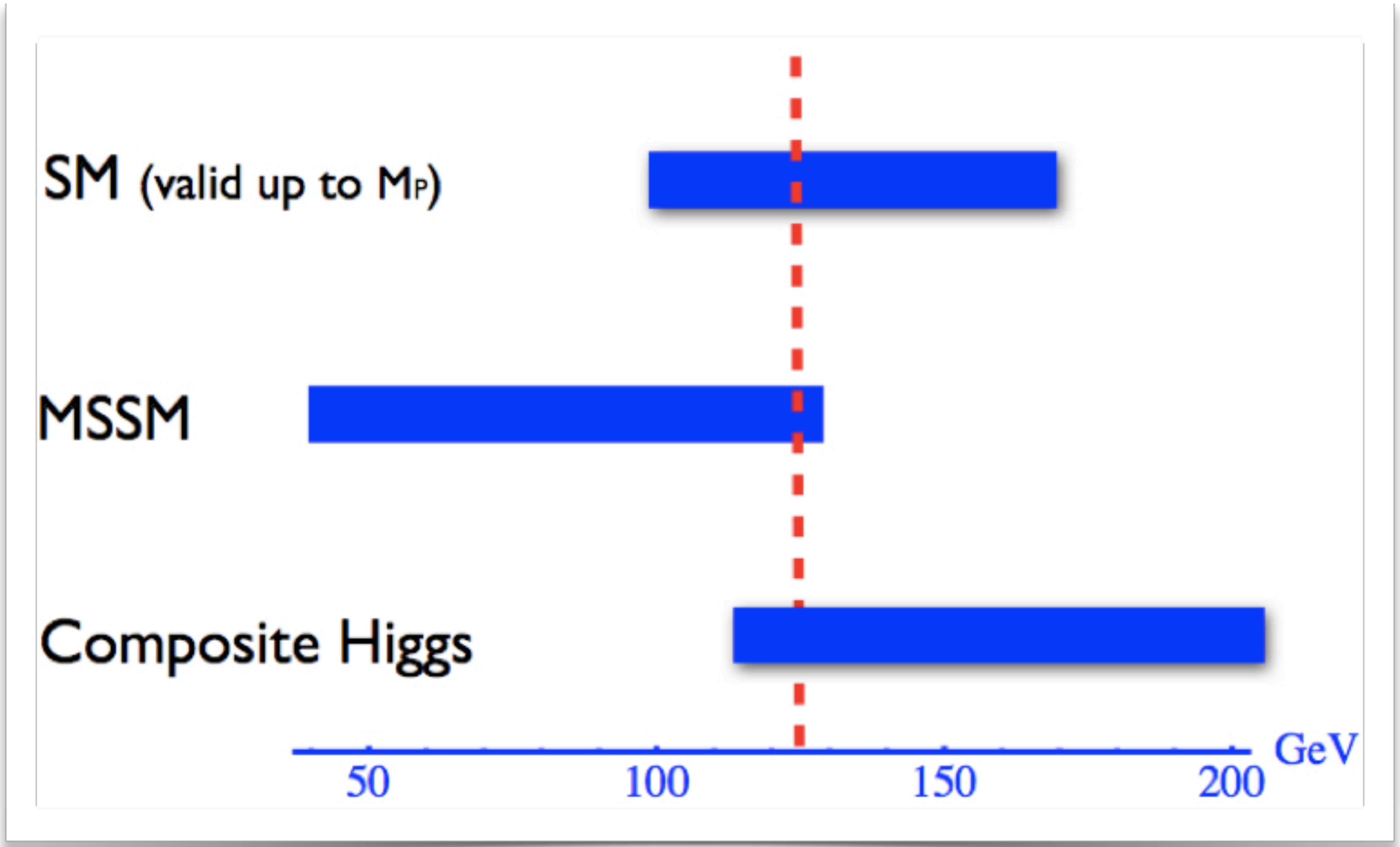
Higgs Top EW QCD NP Flav

4. Be nimble & ready for surprises

Higgs Top EW QCD NP Flav

the new physics

We're learning, hard road



Tao Han

history suggests

http://turningplace.files.wordpress.com/2013/01/aaaa.jpg

particle physics


Higgs
ticl
phys

2. Snowmass 2013 Energy Frontier Process

as a project

what Snowmass is not

We don’t make recommendations

what Snowmass is

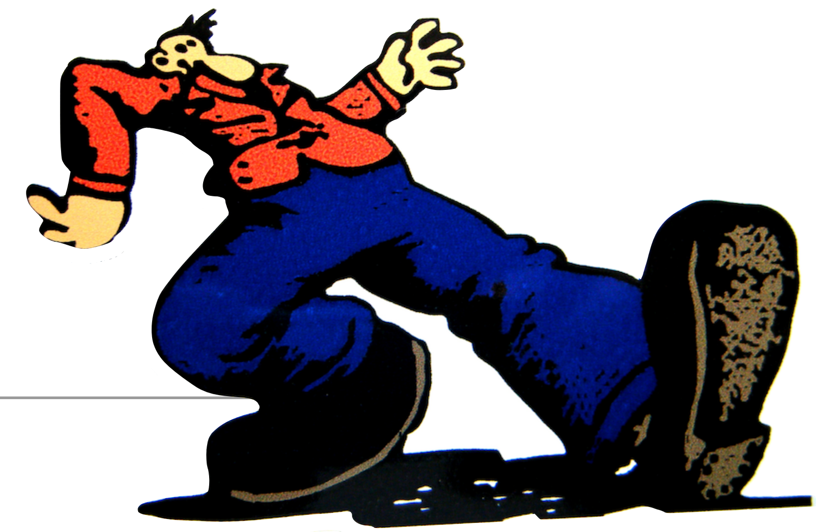
We evaluate by benchmarking

We speculate by calculating

We dream about following the physics

We imagine discovery

our goal should be:

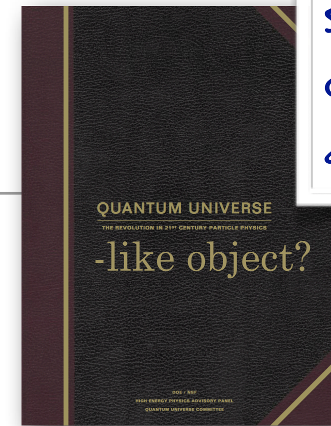


Put our best foot forward

corollary: enthusiastically, but carefully

this is more touchy than you might think.

long process



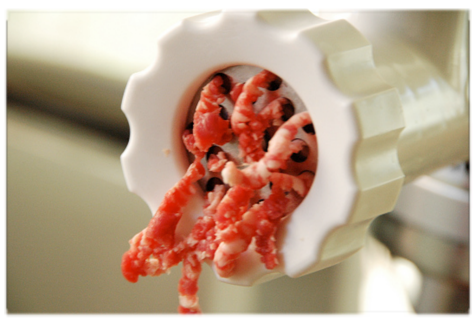
some public-oriented EF document?

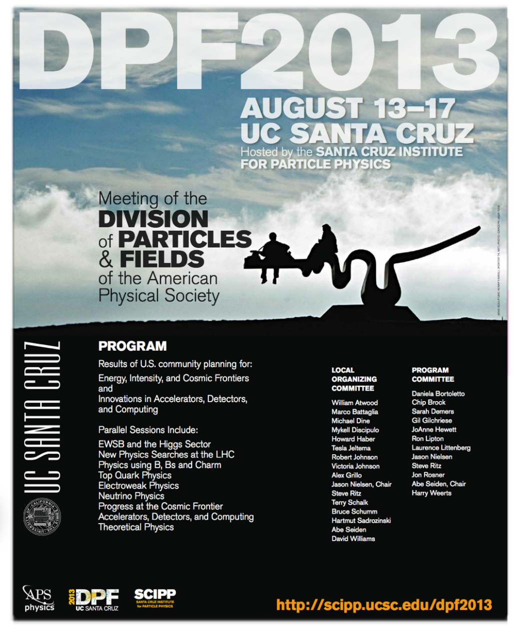
now-July

August

?

August 30?





APS physics

Division of Particles and Fields

http://scipp.ucsc.edu/dpf2013

www.thekitchn.com

what's ideally best for physics

long process

October/November?

Spring 2014?

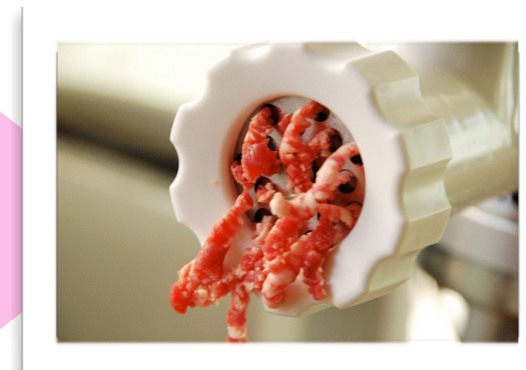
HEPAP

NSF

P5

HEPAP

NSF



what's ideally best for physics & for the National HEP Program

when we're done

`the`  should be unambiguous about

our original goals

EF Goals (circa October):

still good, but more crisp:

Concrete Goals: the science cases

I. **What scientific targets can be achieved before ~2018?**

at design specifications with $\int \mathcal{L}\, dt \sim 100\ \text{fb}^{-1}$)?

II. **What are the scientific cases which motivate HL LHC running:**

"Phase 1": circa 2022 with $\int \mathcal{L}\, dt$ of approximately 300 fb^{-1}

"Phase 2": circa 2030 with $\int \mathcal{L}\, dt$ of approximately 3000 fb^{-1}

How do the envisioned upgrade paths inform those goals?
Specifically, to what extent is precision Higgs Boson physics possible?

III. **Is there a scientific necessity for a "Higgs Factory"?**

IV. **Is there a scientific case today for experiments at higher energies beyond 2030?**

A high energy LHC?
High energy lepton collider?
Lepton-hadron collider?
VLHC?

EF Goals:

Community Goals: the context for this science

I. **Articulate to scientific audiences**

To other Particle Physicists:

EF science in the context of the Intensity and Cosmic Frontiers' goals

To other scientists

II. **Justify to governmental audiences**

OHEP, EPP, OSTP, Congress...beyond our direct agencies

Not only science, but the internationalization of science

III. **Explain to non-specialist audiences**

Universities

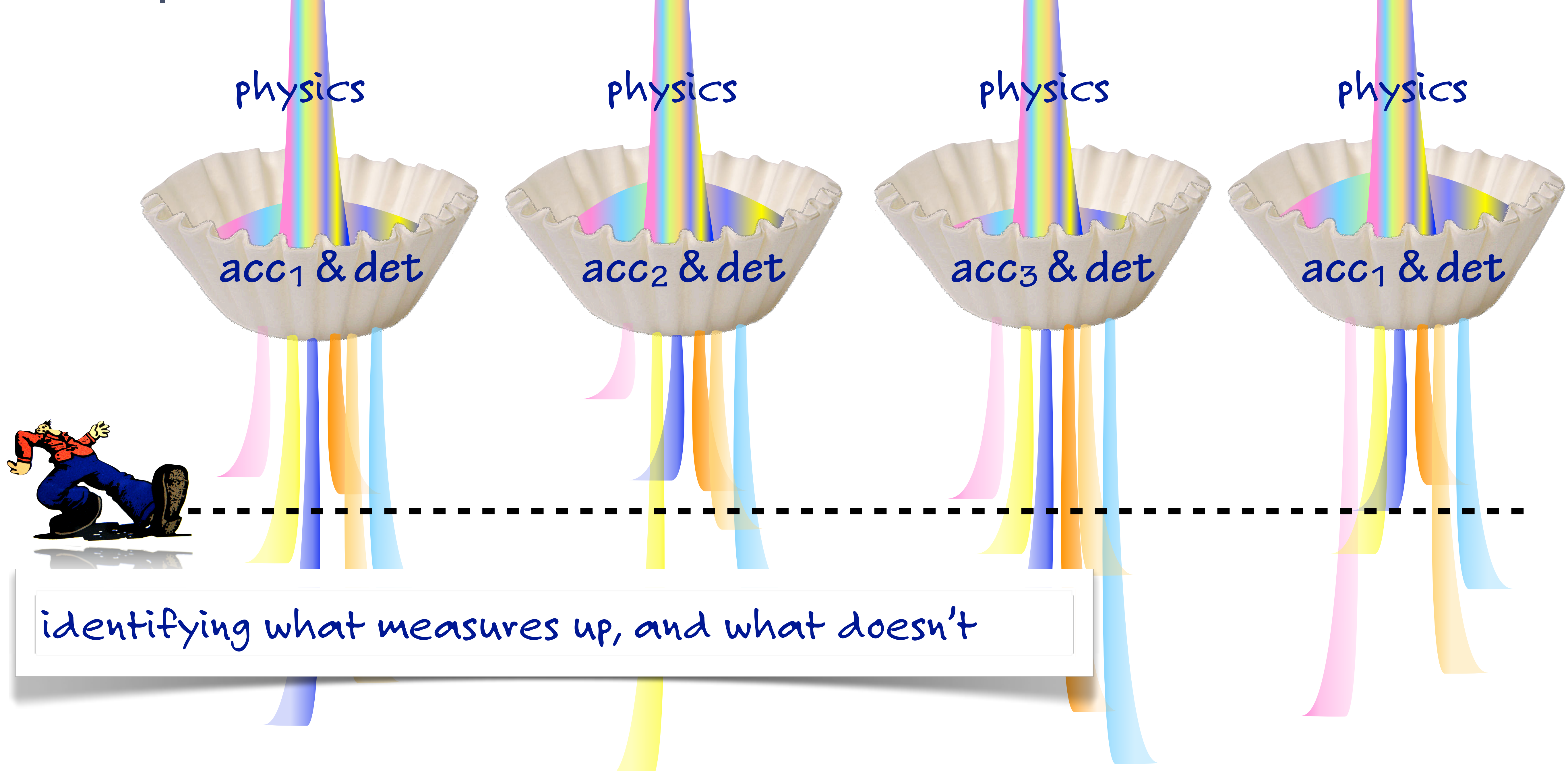
Public

Lectures
Written documentation
Attractive on-line presence

we accomplish the goals by evaluating the physics

tools for filtering

we need to filter the physics opportunities through the capabilities of each machine and conceivable detectors



identifying what measures up, and what doesn't

Candidate scenarios to be addressed by all groups:

A. The LHC with E = 14 TeV and L = 10^{34} cm^{-2} sec^{-1} ✔✔✔✔

B. A luminosity upgraded LHC with: E_{cm} = 14 TeV, L = ~10^{35} $cm^{-2}s^{-1}$ ✔✔✔

C. An energy upgraded LHC !

D. e+e- lepton colliders E_{cm} < ~1 TeV ✔✔✔

E. A circular e+e- collider operating as a Higgs factory. !

F. e+e- or gamma-gamma collider E_{cm} ~ [illegible] TeV ✔✔

G. A mu+mu- collider. ✔

H. A lepton-hadron collider. ✔

I. A VLHC hadron collider with energy well above the LHC energy. ✔

Now converged:

- It is important to point out critical points in energy or luminosity that are essential to realize physics goals.
- For experiments at hadron colliders, a specific question is the effect of the machine environment for high-luminosity running. Do high-luminosity conditions compromise the needed measurements? Are there detector designs or experimental strategies that can ameliorate these problems?

well engineered ✔✔✔ well studied ✔✔ gleam in someone's eye !

candidate accelerator parameterizations

Original “future machines” have evolved into a final list

thanks to Eric Prebys, Mark Thomson, Markus Klute, Mark Palmer

A. hadron colliders

1. LHC 14 TeV, 300/fb , spacing: 25 ns,
   pileup: 50 events/crossing
2. LHC 14 TeV, 3000/fb (HL-LHC) , spacing: 25 ns,
   pileup: 140 events/crossing
3. LHC 33 TeV, 3000/fb (HE-LHC) , spacing: 50 ns,
   pileup: 225 events/crossing
4. VHE-LHC 100 TeV, 3000/fb, spacing: 50 ns,
   pileup: 263 events/crossing
5. VLHC at 100 TeV, 1000/fb , spacing: 19 ns,
   pileup: 40 events/crossing

modified to reflect agreements after the BNL meeting

pileup numbers are the average number of interactions per crossing at the peak luminosity, as explained

B. Lepton colliders

1. *e+e- at 250 GeV (ILC: 500/fb , LEP3: 500/fb, TLEP: 2500/fb),*
   e-/e+ polarization: ILC: 80%/30%, LEP3, TLEP: 0/0
2. *e+e- at 350 GeV (ILC: 350/fb, CLIC: 350/fb, TLEP: 350/fb) ,*
   e-/e+ polarization: ILC: 80%/30%, CLIC: 80%/0, TLEP: 0/0
3. *e+e- at 500 GeV (ILC: 500/fb),*
   e-/e+ polarization: ILC: 80%/30%
4. *e+e- at 1000 GeV (ILC: 1000/fb) ,*
   e-/e+ polarization: ILC: 80%/20%
5. *e+e- at 1400 GeV (CLIC: 1400/fb) ,*
   e-/e+ polarization: CLIC: 80%/0%
6. *e+e- at 3000 GeV (CLIC: 3000/fb) ,*
   e-/e+ polarization: CLIC: 80%/ 0%
7. *mu+mu- at 125 GeV 2/fb , 0 polarization*
8. *mu+mu- at 1500 GeV 1000/fb , 0 polarization*
9. *mu+mu- at 3000 GeV 3000/fb , 0 polarization*

C. Gamma colliders

1. *gamma-gamma at 125 GeV, 100/fb ,*
   80% e- polarization to generate the photon beams

2. *gamma-gamma at 200 GeV, gamma-e at 225 GeV, 200/fb ,*
   80% e- polarization to generate the photon beams

3. *gamma-gamma at 800 GeV, gamma-e at 900 GeV, 800/fb ,*
   80% e- polarization to generate the photon beams

C. Gamma colliders

1. *gamma-gamma at 125 GeV, 100/fb ,*
   80% e- polarization to generate the photon beams

2. *gamma-gamma at 200 GeV, gamma-e at 225 GeV, 200/fb ,*
   80% e- polarization to generate the photon beams

3. *gamma-gamma at 800 GeV, gamma-e at 900 GeV, 800/fb ,*
   80% e- polarization to generate the photon beams

D. e-hadron collider

1. *LHeC 60 GeV e- or e+ on 7 TeV p 50/fb ,*
   90% e- / 0% e+ polarization

fast simulation tools

In this morning session

LHC simulation strategies, Sanjay Padhi

a new fast simulation framework for Snowmass with a single detector model

generation of common backgrounds

thanks to Tom LeCompte, Meenakshi Narain, Jim Olsen, Ashutosh Kotwal, Sanjay Padhi, and Sergei Chekanov

Lepton Collider simulation strategies, Norman Graf

ILC, CLIC, and muon collider

many useful fast simulation tools exist; Norman will review these we accomplish the goals by telling stories

about Discovery

We’re suggesting narratives that describe potential discoveries

For agency use

For public consumption

For fun.

the idea: tell some stories

Take a handful of plausible discovery channels

which might show up as anomalous observables

Flesh them out as a sequence of events:

- What would an experiment need to do to be convincing?
  highlights detector capabilities
- What could it be?
  highlights the variety of physics directions
- What other measurements should show evidence?
  highlights the whole program, cross-frontier?

Some suggested examples:

Standard Model fracture

1. M_W-m_t measurements start to deviate from the SM expectation because in the future: $M_W = 80.400 \pm 10\ \mathrm{MeV/c^2}$

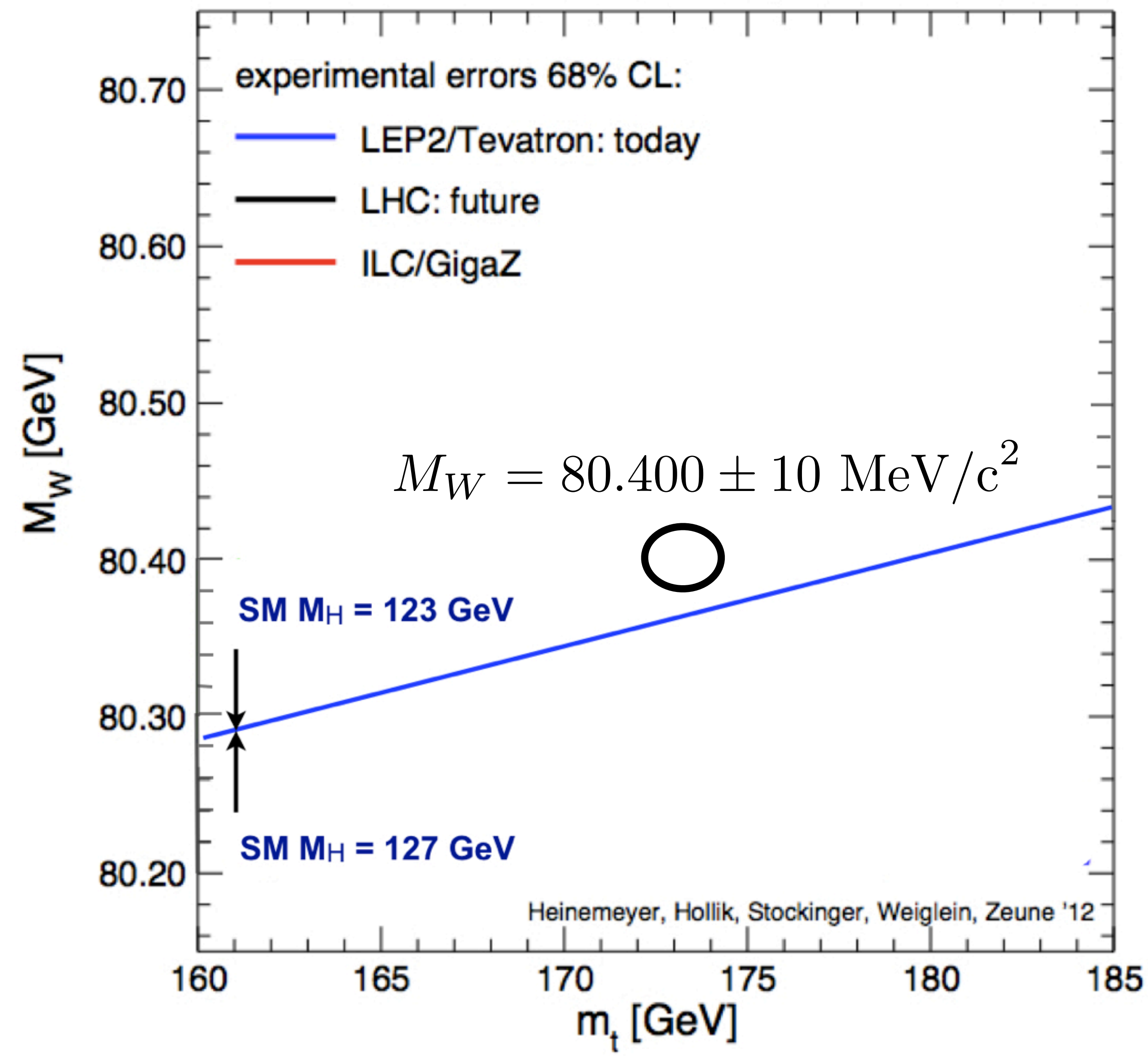
Suppose this started to become apparent?

how do we become convinced?

what could it mean?

what would we do?

What capabilities do we have to follow this surprise?



other "discoveries":

Can we do this or something in this spirit?

2. *WW* production cross section:

    $\sigma(WW) = 1.2 \pm 0.05 \times \sigma(\text{SM})$

3. t-tbar resonance enhancement

    $M(ttbar) = 1.8$ TeV

4. Higgs "signal strength" for fermions

    $\mu(\tau\tau$ and $bb) = 0.5 \pm 0.1$

5. Enhancement in the dijet invariant mass

    $M(jj) > 6000$ GeV

6. A narrow dilepton invariant mass enhancement

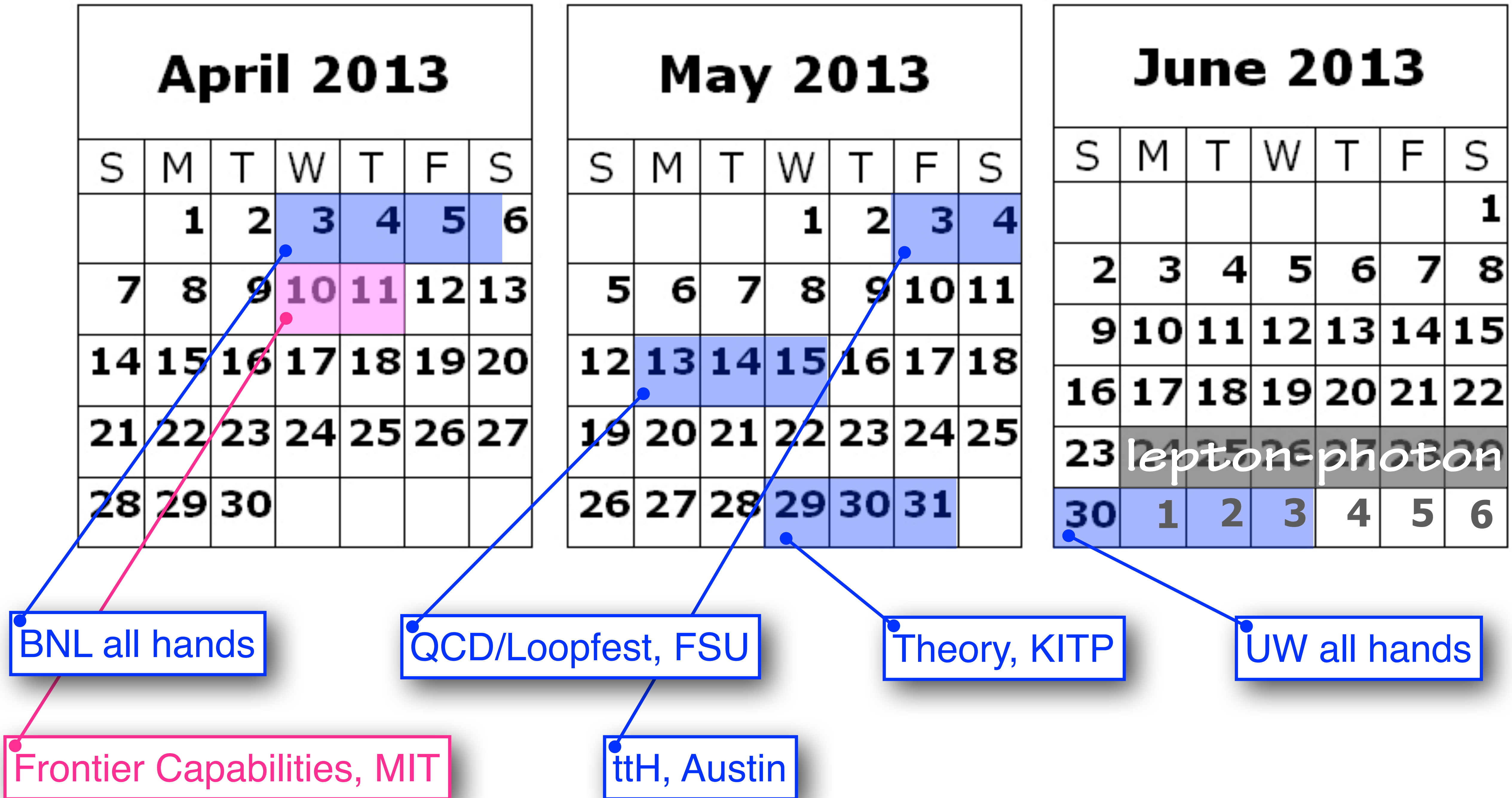
    $\mathrm{M}(\ell\ell) = 3000$ GeV

7. A wide dilepton invariant mass enhancement

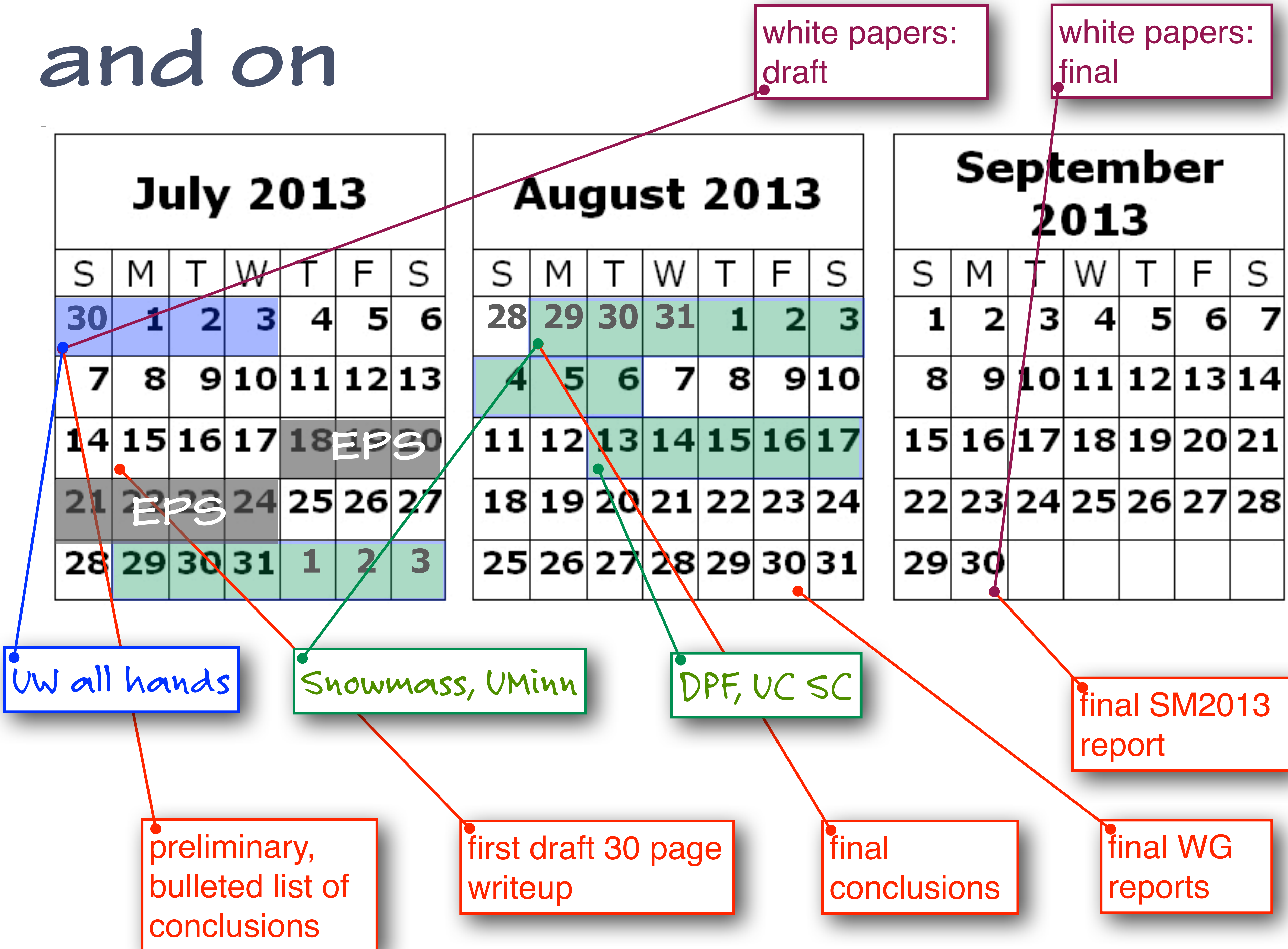
    $\mathrm{M}(\ell\ell) = 2500$ GeV and at a $\sigma(\ell\ell) = 5\%$ that of a sequential Z'

we accomplish the goals by sticking to the calendar

time marches on



and on


white papers: draft
white papers: final
July 2013
August 2013
September 2013
S M T W T F S
EPS
EPS
UW all hands
Snowmass, UMinn
DPF, UC SC
final SM2013 report
preliminary, bulleted list of conclusions
first draft 30 page writeup
final conclusions
final WG reports

3. Housekeeping

this meeting
and
the next.

we begin to accomplish the goals at...this meeting

broad brush:

Many parallel meetings

physics group overlaps here

- We hope you can sketch out how you get from here to recommendations by late June

Some private time for each group

Panel Discussion

Saturday Summaries

show us your maps!

schedule

https://indico.bnl.gov/conferenceDisplay.py?confId=571

Wed	0900-12:35, plenary	lunch, grp mtgs	14:00-17:45, working, parallel			18:30-21:30, banquet
Thu	0900-12:30, working, parallel	lunch, grp mtgs	14:00-16:00, working, parallel	16:20-18:00, panel	18:00-19:30 wine&cheese	20:00 conveners
Fri	0900-12:30, working, parallel	lunch, grp mtgs	14:00-16:00, working, parallel	16:20-18:00, disc'ns		
Sat	0900-12:30, summaries, plenary	lunch, box				

panel discussion

16:20-18:00, panel

EF Goals:

Community Goals: the context for this science

How we state our conclusions matters

What are we trying to do? Why do we care?

Panel is to “try out” words and see how they sound.

Do you have concerns about the field?

Predictions about the physics directions?

be provocative, be productive

Shock and Awe

is not a wise communication strategy

on purpose, or by accident

so let’s talk honestly among ourselves

prime the pump?

Excerpts: Questions from the Cosmic Conveners:*

The message from the LHC seems to be that with data in hand, we consistently outperform expectations for extraction of Higgs properties. **How much is there really for an ILC to contribute?** What key assumptions are we making now that we could relax with ILC inputs?

The current data seem to put large amounts of MSSM parameter space in an uncomfortable position. Clearly some interesting regions remain. **When do we expand to alternatives, such as the NMSSM?** Which ones do we choose? **Are there new paradigms?**

Is there a realistic scenario in which the US has an onshore energy frontier machine in the coming 20 years? If there is, what actions should be taken in the next 5 years? **If there is no such scenario**, how should this impact plans for the coming 20 years?

Others:

Is Naturalness vulnerable?

Why should the US participate in 3 LHC experiments?

At what point would it be apparent that the SM remains rock-solid at the LHC? What would we do?

* see appendix

http://www.freakingnews.com/Pump-Pictures--2675.asp

panel plan

Panelists, 10 minutes each, ~ an hour:

- **from conveners:** Robin Erbacher, Andrei Gritsan, Ashutosh Kotwal, and Markus Luty
- **from community:** Nima Arkani-Hamed and Raman Sundrum

Followed by general discussion, ~ half-hour

Then wine, cheese, and more discussion

some details

Computing Frontier:

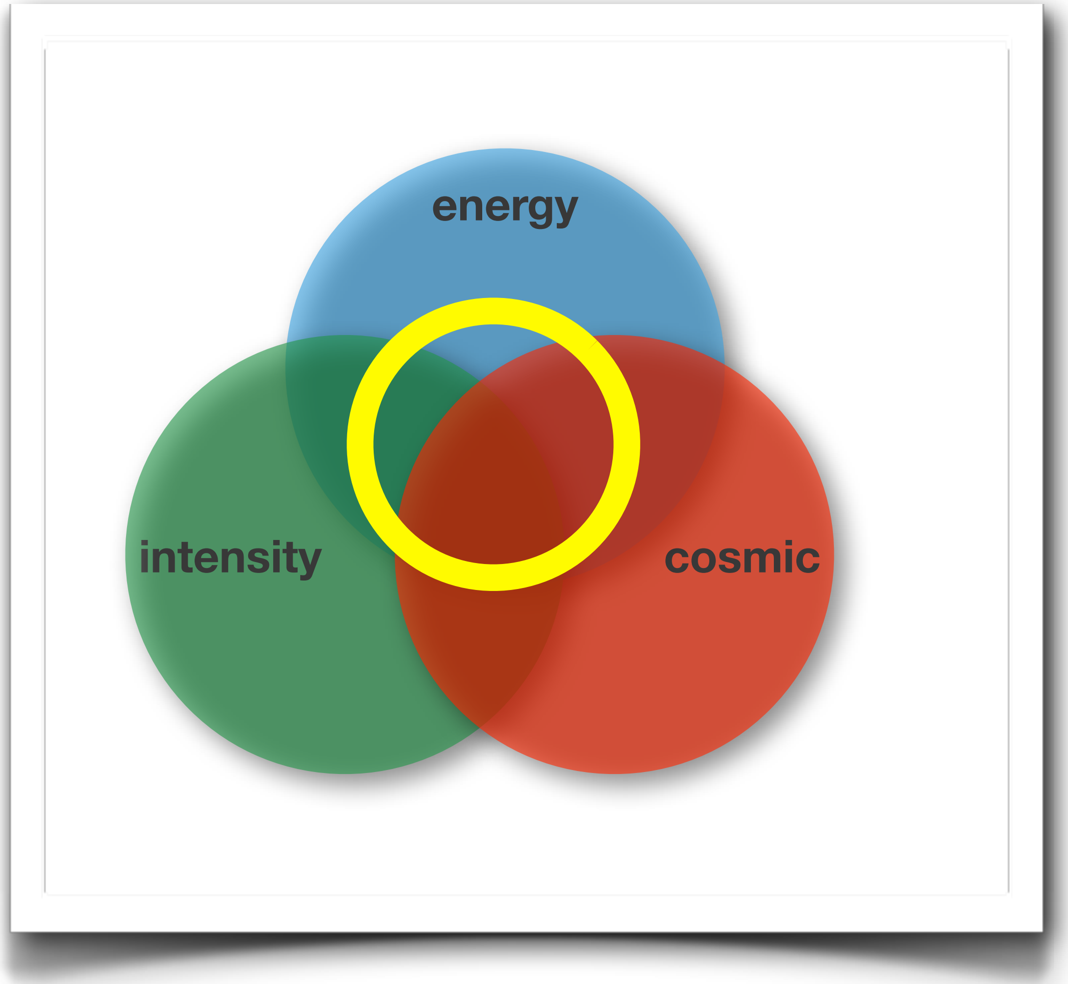
Jim Shank is here...eager to discuss EF computing

Instrumentation Frontier

there's not much participation by the LHC community

Connections among the Frontiers?

Explicit, named representation covering all 3 physics frontiers?



request

speakers for Saturday

maybe you can tell us at the Thursday evening mtg?

Saturday, April 6, 2013

09:00 - 10:30 **Summary Talks, I**

Working Group Summary Talks

Convener: Raymond Brock

Location: Auditorium

- 09:00 **QCD Working Group Summary** *30'* ( )
- 09:30 **Top Quark Properties Working Group Summary** *30'* ( )
- 10:00 **Electroweak Interactions Working Group Summary** *20'* ( )

10:30 - 10:50 Coffee (Berkner)

10:50 - 12:30 **Summary Talks, II**

Convener: Michael Peskin

Location: Auditorium

- 10:50 **Higgs Working Group Summary** *30'*
  Speaker: Heather Logan
- 11:20 **Flavor Mixing and CP Violation Working Group Summary** *30'*
- 11:50 **New Physics Working Group Summary** *30'*

12:30 - 13:30 Box Lunch

prepare for the next meeting

Energy Frontier All Hands #2

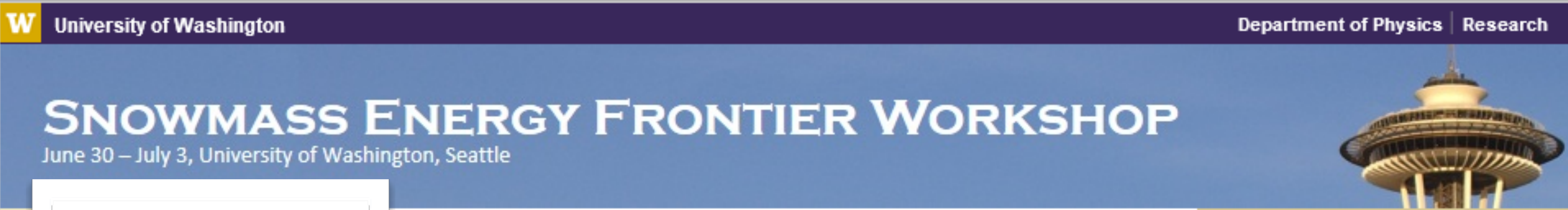
University of Washington, June 30-July 3

Draft conclusions: to be presented & 95% finalized

Stories: outlined

White papers: welcome and useful

during the meeting we'll hammer out details



From Gordon Watts:

June 30th – July 3rd

(right after Lepton-Photon)

At the University of Washington, Seattle

This is the final gathering of the Energy Frontier Group before the Snowmass on the Mississippi Meeting at the end of July

Contact: Gordon Watts
snowmass@uw.edu

http://bit.ly/snowmass2013

(registration will be up soon, along with hotel and travel information)

I’m easily amused.

Particle Physics

We – all of us! – have
always had a model

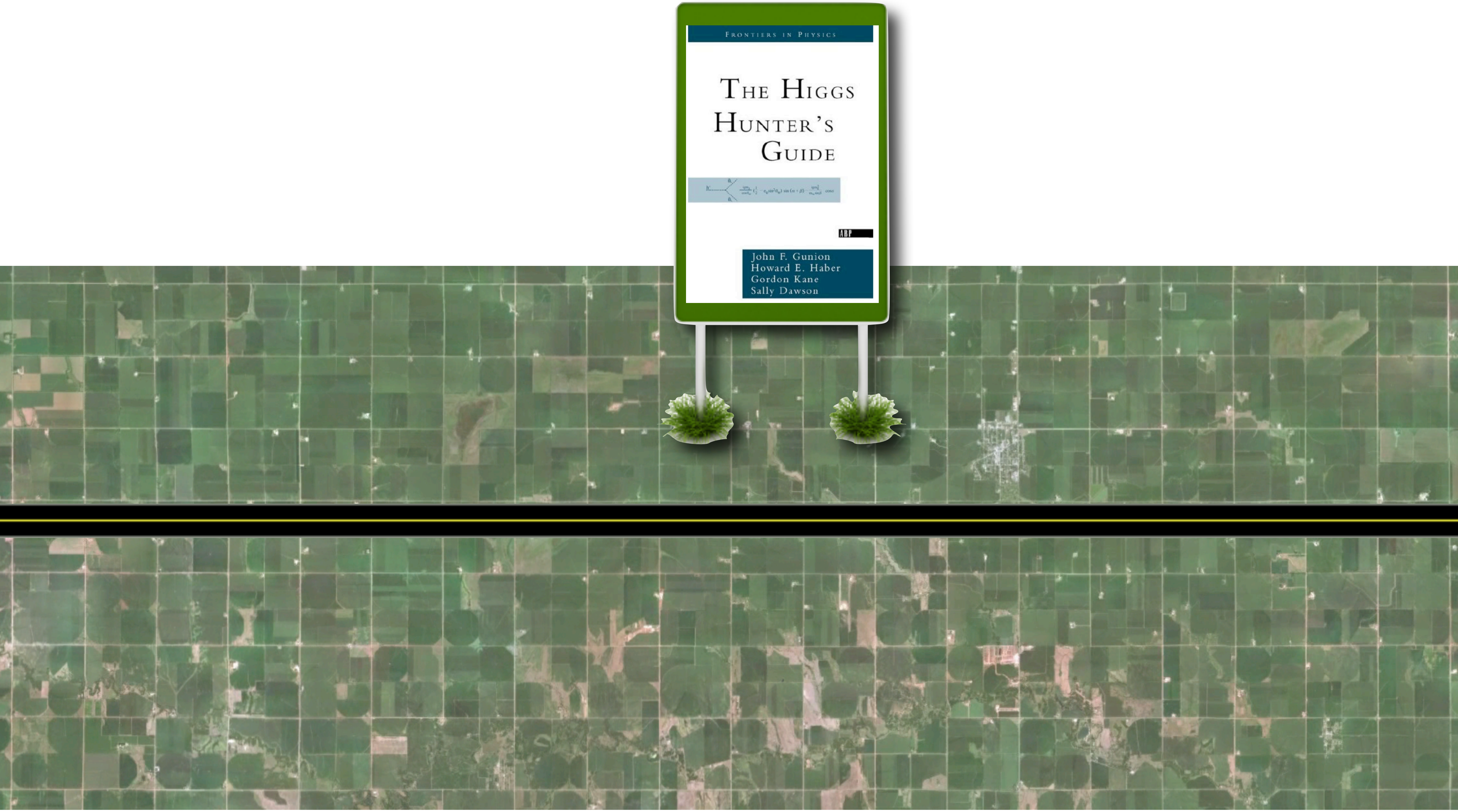
oddly linear for 40 years.

Particle Physics

oddly linear for 40 years.

Particle Physics

oddly linear for 40 years.



we've always had a context

now we're on our own!

I think that's a big deal.

now we're on our own!

I think that's a big deal.

now we're on our own!

I think that's a big deal.

now we're on our own!

I think that's a big deal.

have fun!

please keep the calendar in mind

please talk to us about the “story” possibilities

please keep track of your charges! (appendix)

appendix

EF charges
"Questions" from Cosmic Frontier and Jon Rosner

an expurgated version

of physics groups' charges

Charge to the group,

How will we measure the full phenomenological profile of the Higgs boson?

What level of precision can be achieved at the various proposed accelerators?

What are the unique capabilities of each program?

How will we discover possible additional states in the Higgs sector?

To what extent are properties of the Higgs sector important more generally for fundamental physics?

Charge to the group, Precision Study of Electroweak Interactions:

What are the most important precision observables that will be studied at proposed accelerators?

What level of precision can be achieved, and what is the importance of these measurements?

How well can we probe the couplings of the W and Z bosons?

What do we hope to learn from these measurements?

Charge to the group,

How well can we measure the top quark mass and width at proposed accelerators?

How well can we measure the couplings of the top quark?

How deeply can we probe for rare decays of the top quark?

How can we use these measurements to search for new physics?

Are there new particles that decay to top? How can we find them?

Charge to the group,

What is the new picture of physics at the TeV scale including the new information from LHC?

Can electroweak symmetry breaking still be "natural"? What does this imply?

What types of new particles might be found at the various proposed accelerators?

Are there more effective strategies to discover Supersymmetry, Composite Higgs, and other proposed models?

How can accelerator experiments help to address the problem of dark matter?

Charge to the group,

How can we improve the precision of our understanding of the strong interactions in perturbative QCD, in parton distributions, in non-perturbative physics?

How do we incorporate electroweak interactions into precision QCD?

How can QCD concepts such as jet substructure be used as tools for experimental discovery?

Charge to the group,

What are the viable models of TeV scale physics that include flavor non-universality and CP violation?

What new particles or new signatures are implied by these theories? How will we discover them?

How can high energy hadron colliders uniquely search for new physics in b and tau decays?

“questions” via email$_1$

“...should produce discomfort, but they should promote productive [sic] rather than unproductive discussion.”

[Recommend when reviewing the questions to ask how someone could answer them.]

- HE All. Is there a realistic scenario in which the US has an onshore energy frontier machine in the coming 20 years? If there is, what actions should be taken in the next 5 years? If there is no such scenario, how should this impact plans for the coming 20 years?

  **be more specific about the options.
- HE All. What is our relationship with CERN for the foreseeable future? Would increasing in-kind contributions (hardware built and managed centrally in the US), be important, and at what level?
- HE1. The message from the LHC seems to be that with data in hand, we consistently outperform expectations for extraction of Higgs properties. How much is there really for an ILC to contribute? What key assumptions are we making now that we could relax with ILC inputs?
- HE2. How much do we gain from searches for e.g. triple-gauge-couplings in light of precision electroweak data? Is there any kind of theory where we expect to naturally have SM-like precision measurements, but large deviations in the TGCs?
- HE4. The current data seem to put large amounts of MSSM parameter space in an uncomfortable position. Clearly some interesting regions remain. When do we expand to alternatives, such as the NMSSM? Which ones do we choose? Are there new paradigms?
- HE4: How do we determine experimentally the symmetry protecting the DM lifetime?
- HE5. What kind of slop is present when we tune tools such as Pythia to handle non-perturbative QCD at colliders? Do current uncertainty estimations really do justice or are there systematic effects in the modeling/choice of tool that could be larger? Is it possible we are tuning away subtle interesting and novel effects from new physics? How can we be sure?
- HE6. What is the reasonable target for flavor and CP violation, given no hints for any BSM effects in this direction?

“questions” via email$_2$

“...should produce discomfort, but they should promote productive [sic] rather than unproductive discussion.”

- An extended Higgs sector is a universal feature of supersymmetric theories and also occurs in some well-motivated non-supersymmetric schemes. What are the comparative strengths of (a) precision measurements of couplings of the known state at 125 GeV and (b) direct searches at higher energies? What are the best means to pursue these goals, including via lepton colliders and via high-energy hadron colliders?
- Why do we care about the neutrino mass hierarchy?
- How does the phase delta in the PMNS matrix describing leptonic CP violation affect the baryon number of the Universe? If the connection is not direct, can we frame a narrative that describes the importance of delta in an honest way?
- Can exclusive bottomonium decays be used to validate PYTHIA tunes?
- The existence of dark matter points to some symmetry which guarantees the stability of at least one (possibly more) species. Can this symmetry, if understood, shed any light on the pattern of quark and lepton masses and mixings? (This suggests an area of overlap between the Cosmic and Intensity Frontiers which is not represented in the present version of the Venn diagram.)
- Are there any other measurements besides w and w' which would shed light on the nature of dark energy?
- Is it possible that supersymmetry is realized only at the Planck scale and has something to do with the structure of spacetime itself? How would we know this?
- A light Higgs boson doesn't look good for Technicolor. Are there viable composite-Higgs models remaining, and what are their signatures?